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Research Article

Effect of selenium and vitamin E on growth, antioxidants and immunity of broilers in summer season

K. Sethy[1*], O. S. Andure[1], R. D. Mukherjee[2], R. Kumar[1] and R. P. Kharade[1]

[1]Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Odisha University of Agriculture & Technology, Bhubaneswar - 751 003, Odisha, India; [2]Department of Animal Nutrition, Faculty of Veterinary Science and Animal Husbandry, West Bengal University of Animal & Fishery Sciences, Kolkata - 700 037, West Bengal, India

Abstract

To elucidate the aftermath of selenium (Se) and vitamin E on growth, antioxidants, and immune status of broilers in the summer season, a 42-day experiment was conducted on 120 Vencobb broiler chicks divided into 4 groups, with 30 birds in each group (three replicates of 10 birds each). Group I (control) received a standard broiler ration, while groups II and III received additional supplements of Se (0.3 ppm) as sodium selenate and vitamin E in the form of DL alpha-tocopherol acetate (100 IU), respectively. Group IV was supplemented with both Se (0.3 ppm) and vitamin E (100 IU). Weekly body weights were recorded. At the completion of the trial, samples of blood were taken to examine the birds' antioxidant and immune status. Higher body weight & better FCR were recorded in treated birds compared to control. Similarly, erythrocyte glutathione peroxidase and catalase activity were significantly (P<0.05) greater, and malondialdehyde levels were significantly reduced in the treatment group than the control. In comparison to the unsupplemented control group, the treated broiler chickens exhibited a considerably (P<0.05) higher antibody titre to the Newcastle disease virus and a cell-mediated immune response to PHA-P. Thus, it is evident that giving supplements of Se and vitamin E enhanced the body weight gain, FCR, antioxidant status and immune response of broiler birds during the summer season.

Keywords: Chicken, Immunity, Selenium, Stress, Vitamin E

Highlights

- Selenium and vitamin E are two important micronutrients for broiler chickens
- Supplementation of selenium and vitamin E significantly improved the body weight gain and FCR in broiler chickens
- Addition of selenium and vitamin E prevents summer stress in chickens
- Selenium and vitamin E supplementation improved the immunity in broiler chickens

INTRODUCTION

Antioxidants, like vitamin E and selenium (Se), minimize free radical damage and inhibit lipid peroxidation, which helps to save the cells from reactive oxygen species (Ghazi et al., 2012). In the summer season, body composition & metabolism changes in chickens due to high ambient temperatures (Zeferino et al., 2016). Heat stress is one of the important factors that reduces feed intake, efficiency of feed conversion, weight gain & causes high mortality in birds (Alagawany et al., 2017). The body's oxidation and antioxidant defence systems become unbalanced as a result of heat stress, which may increase reactive oxygen species (ROS). Se and vitamin E play an important role in preventing summer stress in chickens (Debata et al., 2023). Se is a constituent of glutathione peroxidase (GPx), which removes the excess peroxides produced during the summer stress (Sethy et al., 2015). Deficiency of vitamin E, Se, or both had adverse effects on the immunity of broilers (Swain et al., 2000). Vit. E and Se lower the serum interleukin and tumor necrosis factor levels in chickens (Ghazi et al., 2012). For broiler chicken, the Bureau of Indian Standards [BIS] (2007) recommends a dietary intake of 0.15 mg Se/kg dry matter; this level may rise in the summer. Since there are few studies on the combined effect of Se and Vitamin E supplementation in the summer season, the present research work was conducted on Vencobb chickens to assess the growth, antioxidant, and immunity status of the chickens in the summer.

MATERIALS AND METHODS

Experimental protocol: The investigation was performed in April to May 2024 at the Department of Animal Nutrition, C. V. Sc & A. H, OUAT, Bhubaneswar, Odisha. The highest and lowest

*Corresponding Author, E-mail: ksethy@ouat.ac.in

temperatures during the months of April and May were 27.5°C and 37.8°C, respectively, with 60% humidity on average. A total of one hundred twenty Vencobb broiler chicks of day old were partitioned in 4 groups, each with 30 chicks and three replicates (10 birds in each replicate) in a complete randomized design. Control group (Group I) was fed a standard broiler ration; groups II and III were additionally fed with 0.3 ppm Se in the form of sodium selenate and 100 IU/kg vitamin E as DL alpha-tocopherol acetate respectively, whereas group IV was supplemented with both 0.3 ppm Se and 100 IU/kg vitamin E in the feed. The experiment was conducted for 42 days in a deep litter system. Broiler birds were fed as per BIS, 2007. The proximate principles and phosphorus content of the experimental ration were analyzed as per Association of Official Analytical Chemists [AOAC] (1995).

Body weight and FCR: The experimental birds' weights were recorded weekly using an electronic balance throughout the trial period. The difference between the starting and concluding body weights is the body weight gain. By deducting leftover feed remnants from the total amount of feed supplied, the weekly feed intake was determined. To determine FCR feed intake and BW gain was used.

Measurement of antioxidants: Following a 42-day period, a 3-mL blood sample was collected into a sterile microcentrifuge tube having 0.45 mL of acid citrate dextrose anticoagulant (8.0 g citric acid, 22.0 g sodium citrate, 25.0 g dextrose per liter of distilled water). Blood samples were centrifuged and the resultant erythrocyte pellet was diluted to 1:1 by using PBS. For approximation of glutathione peroxidase (GSH-Px), catalase, and lipid peroxidation value (LPO), a 1:20 RBC hemolysate dilution was prepared by mixing 1 mL of RBCs (previously diluted 1:1 with PBS) to 9 mL of distilled water. Lipid peroxidation in red blood cell hemolysate was quantified using the method of Placer et al. (1966), calculating malondialdehyde (MDA) concentration as nanomoles MDA per milligram of haemoglobin, employing an extinction coefficient of $1.56 \times 108\ M^{-1}cm^{-1}$. CAT (Catalase) and (GSH-Px) activity was ascertained by using Bergmeyer (1983), and Paglia and Valentine (1967) respectively.

Immune status of birds: At 6th weeks of age, 100 micrograms of phytohaemagglutinin-P in 0.1 mL of normal saline were intradermally injected into the right foot web of ten birds from each treatment (Edelman et al., 1986). Foot web thickness was measured pre- and post-injection (24 hours) using a digital calliper. The formula below was used to determine the cutaneous basophilic hypersensitivity (CBH) response:

$$\text{CBH response} = \frac{\text{Post injection skin thickness}}{\text{Pre - injection thickness}} \times 100$$

Following the sixth week of experimentation, humoral immune response was assessed using the methodology described by Khalifeh et al. (2009). Following a two-week administration period of RD vaccines, blood samples were collected from each broiler bird. The blood samples were then centrifuged to obtain serum samples and stored at -20°C until further studies. Antibody against the RD vaccine present in serum was measured through a hemagglutination inhibition test. Serum was diluted in a microtiter plate using PBS solution, where RD virus and chicken RBC were added in equal amounts. The $\log_2$ reciprocal of the maximum dilution exhibiting hemagglutination inhibition was calculated.

Statistical interpretation: Data obtained were analyzed using a one-way ANOVA in SPSS version 17.0 (2008). The significance level of $P<0.05$ was estimated as per Duncan's (1955).

RESULTS

Table 1 provides a detailed description of the feed ingredients & chemical composition of the experimental diets. The feed formulations for the experimental birds were as per BIS (2007).

Body weight and FCR: At the age of two weeks, it has been observed that vitamin E alone or in combination with Se significantly ($P<0.05$) improved the body weight in experimental birds (Table 2).

But at the end of the sixth week, it was observed that combined Se and vitamin E in diet significantly ($P<0.05$) increased the body weight compared to other treatments. Similarly, better FCR was observed ($P<0.05$) in all the supplemented birds compared to control in summer season at sixth week of age (Table 3).

Antioxidant status: Supplementing with Se and vitamin E alone as well as combinedly significantly ($P<0.05$) reduced LPO value as indicated by lower MDA levels and significantly increased ($P<0.05$) erythrocytic glutathione peroxidase and catalase activity compared to control (Table 4). The maximum activity of antioxidative enzymes (glutathione peroxidase and catalase) was observed in combined supplemented birds compared to all other treatments.

Table 1. Composition of basal diet

Sl. No.	Items	Prestarter (%) (1-7th day)	Starter (%) (8-21st day)	Finisher (%) (22-42nd day)
1.	Maize	51.53	53.58	56.00
2.	Soyabean	43.00	39.00	35.42
3.	Veg. Oil	1.85	3.80	4.96
4.	DCP	1.89	1.83	1.89
5.	Limestone	0.94	0.94	0.94
6.	DL-Methionine	0.04	0.04	0.04
7.	L-Lysine	0.04	0.04	0.04
8.	Vit. and min. premix	0.19	0.19	0.19
9.	Salt	0.52	0.52	0.52
	Chemical combination (% DM)			
1.	CP	22.65	21.60	19.65
2.	EE	2.70	5.20	5.82
3.	CF	4.80	4.90	5.20
4.	Total Ash	9.25	8.10	8.90
5.	NFE*	60.60	60.20	60.43
6.	Ca	1.50	1.40	1.32
7.	P	0.58	0.60	0.55
8.	Selenium (ppm)	0.007	0.006	0.006
9.	Metabolizable energy (Kcal/kg) *	2980	3090	3210

*Calculated

Table 2. Average weekly body weight (g) of broiler chickens fed different diets in summer season

Week	Groups					P
	I	II	III	IV	SEM	Value
Initial	37.70	38.50	38.20	39.10	0.51	0.44
1st	103.70	110.10	113.30	108.50	5.20	0.41
2nd	390.10^{a}	411.70^{a}	436.30^{b}	433.70^{b}	7.31	0.04
3rd	754.50^{a}	804.80^{b}	844.90^{bc}	874.20^{c}	11.90	0.01
4th	1302.10^{a}	1359.20^{b}	1382.50^{b}	1384.60^{b}	14.67	<0.01
5th	1802.40^{a}	1845.00^{b}	1857.20^{b}	1923.40^{c}	20.13	<0.01
6th	2260.80^{a}	2376.40^{b}	2379.40^{b}	2473.60^{c}	26.05	<0.01

^{abc}Values bearing different superscripts in a row differ significantly (P<0.05)

Table 3. Cumulative weekly FCR of experimental birds in summer season

Week	Groups					P
	I	II	III	IV	SEM	Value
1st	1.32	1.32	1.27	1.28	0.02	0.14
2nd	1.36	1.32	1.32	1.30	0.01	0.08
3rd	1.51^{b}	1.34^{a}	1.42^{a}	1.39^{a}	0.03	0.05
4th	1.56^{b}	1.48^{ab}	1.43^{a}	1.48^{ab}	0.02	0.03
5th	1.62^{b}	1.52^{a}	1.56^{ab}	1.50^{a}	0.02	0.03
6th	1.70^{b}	1.60^{a}	1.64^{a}	1.57^{a}	0.03	0.01

^{ab}Values bearing different superscripts in a row differ significantly (P<0.05)

Immunity of birds: At the 6th week of age, the CBH response against PHA-P and antibody titers (log_2) against RD vaccine inoculation were significantly (P<0.05) higher in all treated birds compared to control. It was also been observed that combined Se and vitamin E supplementation gave maximum antibody titre compared to all other treatments (Table 4).

DISCUSSION

Body weight and FCR: Supplementation of Se or vitamin E alone or in combination improved the BW gain and FCR of experimental birds. Chitra et al. (2016) also reported that during summer season, addition of Vit. E & Se in the feeds of Japanese quail at various doses resulted in enhancement of gain in weight and feed conversion ratio compared to unsupplemented groups. According to Sahin and Kucuk (2001) there may be a synergistic effect between Vit. E (250 mg/kg) and Se (0.2 mg/kg) in reducing the detrimental effects of oxidative damage, which is why using these nutrients together, improved the body weight and FCR of Japanese quails exposed to continuous heat stress. It has been claimed by Bora et al. (2024) that production performance of broiler chicken can be enhanced by supplementing their diet with Se at a level 0.2 mg/kg and vitamin E at a level of 100 mg/Kg in summer season. Results of Lima et al. (2025) and Khalifa et al. (2021) support improved FCR in summer season with respect to decreased FCR. Contrary to these, according to Ghazi et al. (2012), broiler performance remained unaffected by single or combined Vit. E @ 125 mg/kg and Se @ 0.5 mg/kg supplementation at 37°C environmental temperature. Vitamin E and Se are crucial for preventing oxidative damage to cells, which enhances bird's growth and performance throughout the summer season (Wasti et al., 2020). Enhanced body metabolism due to Se and vitamin E supplementation may be

Table 4. Antioxidant status (U/mg Hb) and immunity of birds

Attributes	Groups					P
	I	II	III	IV	SEM	Value
			Antioxidative status			
GPx	2060.10[a]	2480.80[c]	2380.00[b]	3017.00[d]	15.80	<0.01
Catalase	11.40[a]	16.18[bc]	15.37[b]	18.40[c]	0.12	<0.01
LPO	3.85[c]	2.64[b]	2.58[b]	2.28[a]	0.13	<0.01
			Immune status			
CBH response (%)	102.30[a]	165.50[b]	182.60[c]	199.50[cd]	9.30	<0.01
Log_2 value HA titre	4.88[a]	5.53[b]	5.44[b]	6.01[c]	0.13	<0.01

[abcd]Values bearing different superscripts in a row differ significantly (P<0.05)

the cause of increased feed conversion efficiency in birds in summer season (Mohamed et al., 2024)

Antioxidant status: Enhanced activity of GSH-Px and catalase in the red blood cells of broiler chickens suggested improved stress tolerance. Vit. E and selenium were incorporated @ 250 mg/kg and 1 mg/kg, respectively, to the basal diet of Cobb male broiler chicken, which improved antioxidant status in heat-stress birds (Calik et al., 2022). The combined effect of Se (0.2 ppm) and vitamin E (250 mg/kg) augmented antioxidant capacity and elevated GPx1 and GPx4 mRNA expression levels, potentially mitigating the adverse stress caused by summer heat (Kumbhar et al., 2018). Supplementation with vitamin E and Se mitigated stress by reducing lipid peroxidation, potentially enhancing avian performance through decreased metabolic nutrient demands and redirection of nutrients towards muscle growth (Rao et al., 2013). The synergistic action of antioxidants, such as vitamin E and Se, destroy cell-damaging free radicals and this improves the digestion, absorption, utilization, and metabolism of key dietary nutrients, supporting optimal health and effective weight management (Abbas et al., 2019).

Immunity of experimental birds: A statistically significant (P<0.05) improvement in antibody titers (log_2) against RD antigen and CBH reaction against PHA-P was observed in all treated birds at the 6th week of age compared to the control group (Table 4). Supplementing with 0.5 mg/kg Se and 125 mg/kg vitamin E enhances humoral immunity by inducing immunoglobulins, especially IgM, the antibody produced upon initial antigen exposure to broiler birds in summer season (Habibian et al., 2014). Similarly, supplementation with 100 mg/kg vitamin E along with 0.3 mg/kg Se effectively enhances immune function by modulating cytokine expression and immunoglobulin levels (Dalia et al., 2018). Likewise, adding vitamin E (150 IU/kg) and Se (0.2 mg/kg) to broiler chicken diet resulted in increased antibody titers in summer season (Bora et al., 2025). Furthermore, Ziaei and Pour (2013) suggested that incorporating dietary Se (0.75 mg/kg) and vitamin E (250 mg/kg) may improve the immunological response in laying hens. Studies indicate that vitamin E and Se improve plasma cell, macrophage and lymphocyte survival, proliferation, and function as these cells protected from oxidative damage (Ahmadi et al., 2018). As a result, while under stress, vitamin E and Se supplements improve the immunological response (Attia et al., 2016).

Based on the aforementioned experiment, it can be inferred that supplementation of Se (0.3 ppm) and vitamin E (100 IU) improved BW gain, FCR, antioxidant, and immune status of broiler birds in the summer season.

Conflict of interest: Authors have no conflict of interest.

Author's contribution: KS, OSA: Conception and design of experiment; KS, RDM, RK: Acquisition of data; KS, RK, RPK: Performed statistical analysis of data, interpretation of the result and provided technical efforts in drafting of the manuscript. The final version was approved by all.

Data availability statement: Data of research conducted is preserved by the author and will be made available on demand.

Ethical approval: This study was conducted after an approval from "Institutional Animal Ethical Committee (IAEC)" was obtained vide reference number 433/GO/Re/S/01CCSEA.

Use of artificial intelligence tools: During the preparation of this work, the author(s) used Turnitin software to check the plagiarism. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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